

What is claimed:

1. A digital diagnostic video system for diagnosing malfunctions and other errors in the operation of manufacturing machinery, said machinery having a plurality of machine sensors located at monitoring zones for detecting prescribed errors and causing sensor signals to be generated upon occurrence of said errors,  
5 said system comprising:

a video camera associated with a machine sensor located at a monitoring zone for producing real-time video output of the machinery operation desired to be monitored by said camera and sensor;

10 a central control unit having a computer processor continuously receiving the video output from said camera during normal machinery operation;

a temporary computer memory in communication with said processor continuously storing said video output in real time;

said processor in communication with said sensor for receiving said  
15 sensor signal to provide a trigger signal when said sensor signal is associated with a prescribed trigger event;

a permanent memory for storing a pre-event video including a first preset length of the video output depicting machinery operation occurring immediately before said trigger signal and storing a post-event video of a second  
20 preset length of the video output depicting machinery operation occurring immediately after said trigger signal;

a computer program having a set of operating instructions embodied

in computer readable code executable by said processor to control the recording and storing of said pre-event and post-event videos, said program including capture instructions for copying at least said pre-event video from said temporary memory into said permanent memory in response to said trigger signal, recording said post-event video in response to said trigger signal, and saving said post-event video in said permanent memory along with said pre-event video to provide a trigger event video;

whereby said trigger event video may be displayed on said display monitor and replayed to assist in diagnosing said trigger events and errors.

10           2.     The system of claim 1 wherein said central control unit includes a display monitor associated with said processor having a display screen for continuously displaying said video output during machinery operation.

          3.     The system of claim 1 including a plurality of said cameras located at a prescribed monitoring zone associated with a prescribed trigger signal and  
15     required to effectively provide video of the trigger event, and said pre-event and post-event videos containing video output from each of said cameras.

          4.     The system of claim 1 wherein said machinery includes a programmed logic controller (PLC) receiving said sensor signals for controlling normal machinery operation in response to said sensor signals, and said processor being in  
20     communication with said PLC to simultaneously receive and process said sensor signals for generating said trigger signal corresponding to a prescribed trigger event in machinery operation represented by one or more of said sensor signals.

5. The system of claim 4 where said processor is set up to produce said trigger signal in response to a combination of two or more of said sensor signals.

6. The system of claim 4 including a local area network (LAN) connecting said machine PLC to said control unit processor for concurrent transmission of a plurality of machine sensor signals received by said PLC from said sensors.

7. The system of claim 6 wherein said LAN includes an Ethernet, and said machine PLC includes a converter for converting said sensor signals for transmission over said Ethernet.

8. The system of claim 1 wherein said operating instructions include instructions for storing said post-event video real time in said temporary memory containing said pre-event video in response to said trigger signal, and copying said pre-event and post-event videos into a video file in said permanent memory.

9. The computer program of claim 1 wherein said operating instructions include display instructions for displaying said trigger event video in response to a view request input on said display monitor so that the machine operation before and after the trigger event may be studied for diagnostic purposes.

10. The system of claim 1 wherein said operating instructions include report instructions embodied in computer readable code for creating a video data file including said pre-event video and said post-event video, along with a time and, date, for said trigger event.

11. The system of claim 1 wherein said computer program includes set-up instructions for selecting a first preset duration for said pre-event video and a

second preset duration for a said post-event video, selecting one or more machine sensor signals required to generate said trigger signal, and selecting one or more cameras producing the pre-event and post-event videos for the trigger event.

12. The system of claim 1 wherein said operating instructions include  
5 instructions for (1) continuously receiving a video of the machinery operation in real time, (2) continuously storing video in a temporary memory in real time, (3) continuously displaying the video on a display screen in real time, (4) continuously receiving available sensor signals, (5) processing said sensor signals to determine if said trigger event has occurred, and (6) continuing instructions (1) through (5) if a  
10 trigger event has not occurred.

13. The system of claim 1 wherein said operating instructions include instructions for generating said trigger signal and recording the time and date of the trigger event upon occurrence of said trigger signal; storing said video output according to a first preset duration for said pre-event video and a second preset  
15 duration for said post-event video upon occurrence of said trigger signal; copying video from said temporary memory into said permanent memory of said first preset duration to provide said pre-event video upon the occurrence of said trigger signal; beginning the recording of said post-event video upon occurrence of said trigger signal, and storing said post-event video in said permanent memory after said  
20 second preset duration has expired.

14. The system of claim 13 wherein said operating instructions include

instructions for storing said post-event video real time in said temporary memory containing said pre-event video in response to said trigger signal and copying said pre-event and post-event videos into a video file in said permanent memory.

15           15.     The system of claim 13 wherein said operating instructions include instructions for storing said pre-event and post-event video from said permanent memory in a data file along with text representing said time, date, and a trigger name identifying location of the trigger event so that video before and after the trigger event and text information can be selected and displayed to assist in the diagnosis of the trigger event.

10           16.     The system of claim 1 wherein said display monitor includes a touch screen input for inputting data and information into said processor.

              17.     The system of claim 1, including a machine control and data analysis system for monitoring the production performance of the operating machinery such as down time, speed, production, and alarm signals; and  
15           said control and data analysis system being in communication with said processor of the digital diagnostic system for displaying information from said video file along with performance data.

              18.     A diagnostic system for assisting in the diagnosis of a malfunction and other errors in a manufacturing process implemented by an operating machine  
20           having a plurality of machine sensors located at machine monitoring zones for detecting errors at said zones and generating sensor signals representing said

errors, and a programmed logic controller (PLC) receiving said sensor signals for controlling the machinery operation in response to said sensor signals, said system comprising:

a central control unit having a computer processor in communication  
5 with a computer readable medium having a permanent memory;

a temporary computer memory in communication with said processor;

a plurality of video cameras located at said monitoring zones  
associated with specific sensors at said monitoring zones, said processor in  
communication with said cameras for receiving video output depicting the operation  
10 of the manufacturing process; and

a set of computer readable instructions embodied within said  
computer readable medium executable by said processor including:

set-up instructions for receiving input selecting a first preset duration  
for a pre-event video and a second preset duration for a post-event video  
15 from said video cameras, receiving input selecting one or more machine  
sensor signals required to generate trigger signals triggering production of  
the pre-event video and post-event video, and receiving input selecting one  
or more cameras producing the pre-event and post-event videos for each  
trigger signal, and

20 operating instructions executable by said processor for continuously  
storing video output in said temporary memory depicting machinery operation  
from said cameras, continuously receiving available sensor signals,

processing said sensor signals to determine if a trigger signal is required, continuing the preceding operating instructions if a trigger signal is not required, and upon occurrence of a trigger signal copying video from said temporary memory into said permanent memory of said first preset duration to provide said pre-event video and beginning the recording of said post-event video and storing said post-event video in said permanent memory after said second preset duration has expired.

16. 19. The system of claim 18 wherein said operating instructions include instructions for storing said pre-event and post-event videos in a video file in said permanent memory along with a trigger name associated with said trigger signal, and time and date information so that video output before and after the trigger event can be displayed and reviewed to assist in the diagnosis of the trigger event.

20. The system of claim 19 wherein said set-up instruction includes instructions for receiving input selecting names for trigger events corresponding to selected errors in machinery operation.

21. The system of claim 18 wherein said operating instructions include instructions for generating trigger signals and recording the time, date, and location of the trigger event upon occurrence of a trigger signal, storing said pre-event video and said post-event video according to said first preset duration and said second preset duration, respectively, in response to said trigger signal, and upon occurrence of said trigger signal copying video from said temporary memory to said permanent memory of said first preset duration to provide said pre-event video.

22. The system of claim 18 wherein said operating instructions include instructions for storing said post-event video in said temporary memory containing said pre-event video and copying said pre-event and post-event videos into a video file in said permanent memory.

5           23. The system of claim 18 wherein said operating instructions include display instructions continuously displaying the video on a display screen in real time concurrently with said video being stored in said temporary memory.

24. The system of claim 18 including compression chips individually associated with said video cameras in the system for compressing the video output  
10 of said cameras prior to transmitting the video output to the processor.

25. A computerized method for assisting in the diagnosis of malfunction and other errors occurring in the operation of manufacturing machinery where machine sensors are strategically placed at machinery monitoring zones prone to malfunction, said method comprising;

15           selecting specific errors which need to be detected in order to define trigger events at the monitoring zones requiring generation of trigger signals;

            assigning a number of sensors at the monitoring zones required to detect the occurrence of a trigger event;

            associating a number of video cameras with trigger events and  
20 sensors at said monitoring zones having video output sufficient to effectively diagnose errors occurring at the monitoring zones;



continuously storing the video output in real time in a temporary computer memory during operation of the machinery;

continuously displaying the video output on a display monitor in real time while simultaneously storing the video output;

5                   producing a pre-event video from video output stored in the temporary memory upon occurrence of said trigger signal depicting machinery operation occurring before said trigger signal;

                  producing a post-event video upon occurrence of the trigger signal depicting machinery operation occurring after said trigger signal; and

10                  storing said pre-event video and post-event video in a video file in a permanent computer memory of a computer readable medium along with text information identifying the trigger event.

26.     The method of claim 25 including storing said post-event video in said temporary computer memory containing said pre-event video upon occurrence of  
15   said trigger signal, and saving said pre-event and post-event video from said temporary memory in said permanent memory after said post-event video is completed.

27.     The method of claim 25 including compressing said video output prior to transmitting said video output to said temporary memory.

20           28.    A computerized method for diagnosing errors in manufacturing processes implemented by operating machinery having machine sensors for

sensing operational errors, and a machine controller for controlling the machinery operation in response to the sensor signals, said method comprising:

sensing machinery operation malfunction and other errors and generating sensor signals representing the errors;

5 pre-defining triggers signals based on said sensor signals for controlling real time storage of video output from one or more video cameras;

executing computer readable instructions embodied in a computer readable medium on a computer processor including:

continuously storing said video output in temporary memory in real  
10 time;

displaying said input from video cameras on a display screen in real time;

communicating sensor signals from the machinery controller to said computer processor;

15 recording date and time, identification of the sensors generating said sensor signal;

processing the sensor signals and generating a trigger signal in response by one or more sensor signals; representing a pre-defined trigger event;

storing said video output stored in temporary memory into permanent  
20 memory upon occurrence of said video signal;

creating a trigger video file containing said date, time, and identification of said trigger event; and

saving said video in a computer readable medium.

29. The method of claim 28 including storing a first preset amount of said video output as a pre-event video depicting machinery operation occurring before the trigger signal and storing a video output as a post-event video depicting the machinery after occurrence of the trigger signal.

30. The method of claim 29 including storing said pre-event video in temporary memory immediately upon occurrence of said trigger signal currently with beginning storage of said post-event video in said temporary memory, and saving said pre-event and post-event videos in a video file in permanent computer memory.

31. The method of claim 29 including providing a computer processor having computer readable medium containing said permanent memory, and a temporary computer memory in communication with said computer readable medium; wherein said method includes the steps of allocating portions of said temporary memory for storing video output from said video cameras to define preselected memory amounts for said pre-event and post-event videos in temporary memory; and storing said pre-event and post-event videos in said preselected memory amounts for said video cameras upon occurrence of trigger signals associated with said cameras.

32. The method of claim 29 including set up instructions for receiving an input selection to preset the allocation of said pre-event video and said post-event video in said preselected memory amounts.

33. The method of claim 32 including allocating said preselected memory

amounts to generally equal the total amount of pre-event and post-event video corresponding to said preset durations.

34. The method of claim 33 including the steps of selecting errors requiring trigger signals, assigning sensors to detect the selected errors, and  
5 associating certain video cameras with said selected errors at predetermined area of the operating machinery required to adequately video events surrounding the trigger signals.

35. The method of claim 31 including receiving said sensor signals at the machine controller for the machinery, and simultaneously transmitting said sensor  
10 signals over a local area network to said computer processor.

36. The method of claim 28 including discontinuing operation of said machinery in response to said trigger signal.

37. The method of claim 28 including compressing said video output prior to transmitting said video output to said temporary memory.

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